

Space Environmental Effects (SEE) Testing Capability

NASA / Marshall Space Flight Center

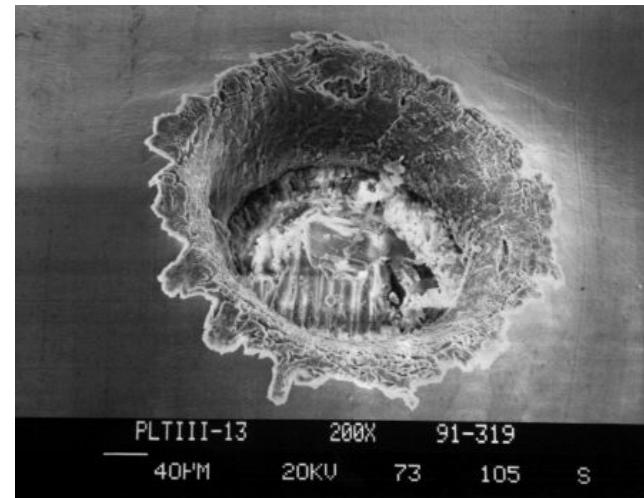
H. DeWitt Burns

June 2012

- Understanding the effects of the space environment on materials and systems is fundamental and essential for mission success.
- If not properly understood and designed for, the space environment can lead to materials degradation, reduction of functional lifetime, and system failure.
- Ground based testing is critical in predicting performance
- NASA/MSFC's expertise and capabilities make up the most complete SEE testing capability available.

Capabilities Summary

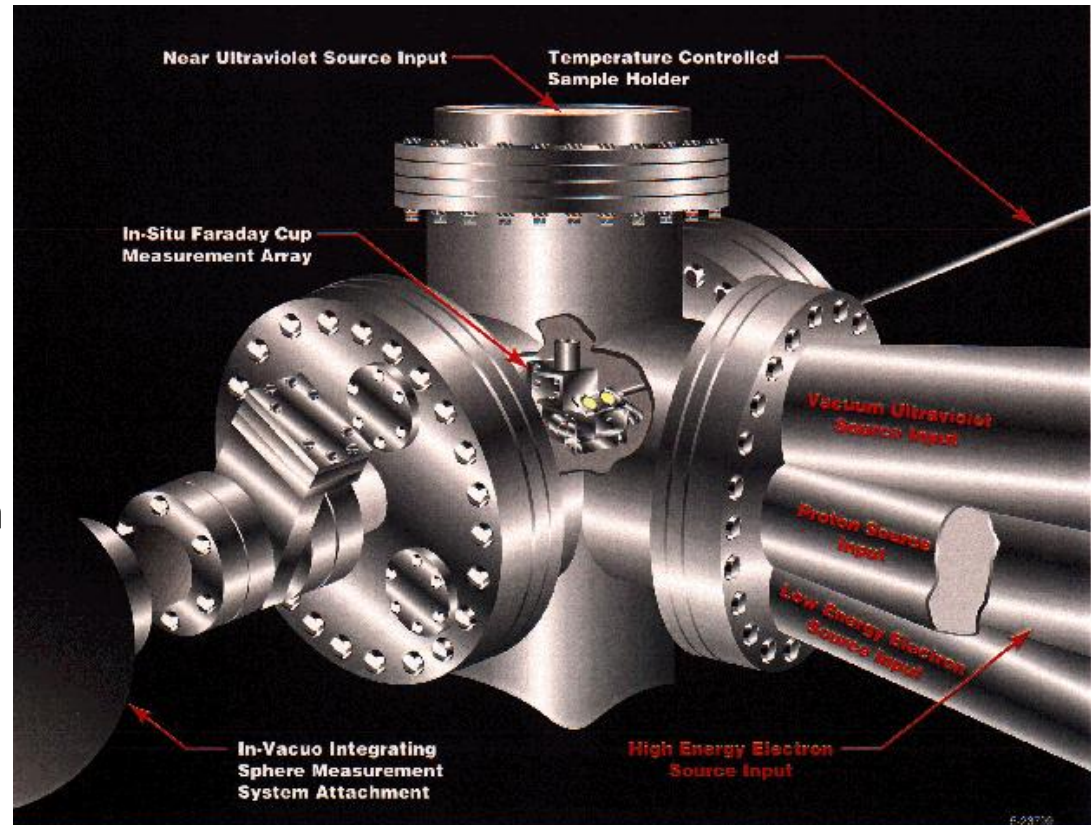
- Ionizing Radiation –
 - Combined Space Environmental Effects
 - Solar Wind Facility
- Ultraviolet Radiation
- Atomic Oxygen (AO)
- Space Plasma Interaction – charging/arcing
- Hypervelocity Impact
- High Temperature Emmissivity Measurement System (HiTEMS)
- Lunar Environments
- Analytical Capabilities
- Flight Experiments



Ionizing Radiation - Combined Space Environmental Effects

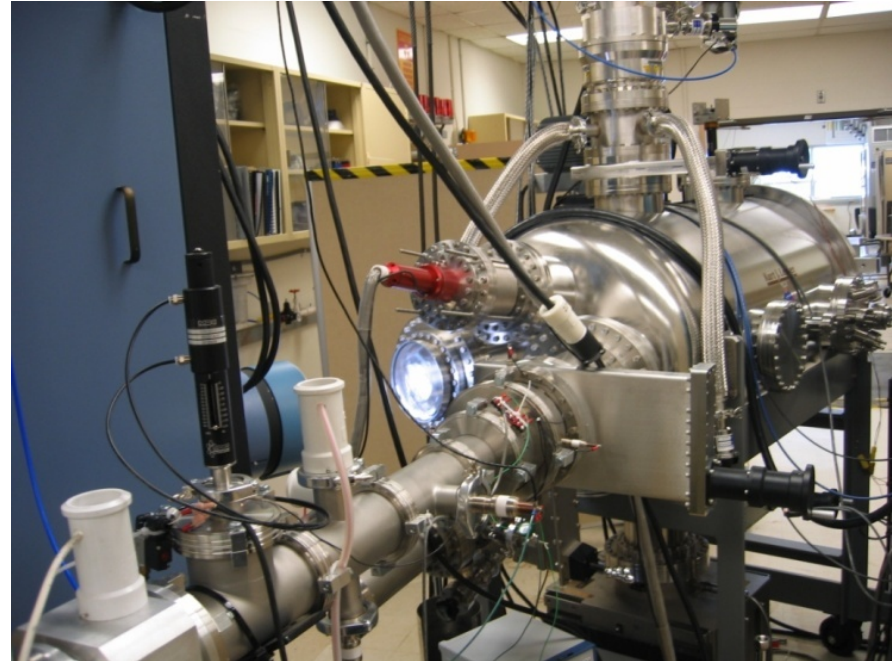
Pelletron Particle Accelerator System

- Low Energy Electrons
 - 1 keV – 100 keV
- High Energy Electrons
 - 100 keV – 2.5 MeV
- Protons
 - 40 keV – 700 keV
- Vacuum Ultraviolet Radiation (VUV)
 - 110nm – 160 nm
 - Deuterium Lamp
- In-Vacuum Reflectance Measurement
- 4-inch Diameter Exposure Area



Ionizing Radiation – Solar Wind Facility

- Low Energy Electrons
 - 1 keV – 100 keV
- Low Energy Protons
 - 1 keV – 30 keV
- Ultraviolet Radiation
 - Vacuum UV & Near UV
- 12-inch Diameter Exposure Area



Other systems are available with low-energy electrons and UV only

Test chambers and exposure parameters can be customized to meet a wide range of customer requirements

Ultraviolet (UV) Radiation

Combined Test Systems

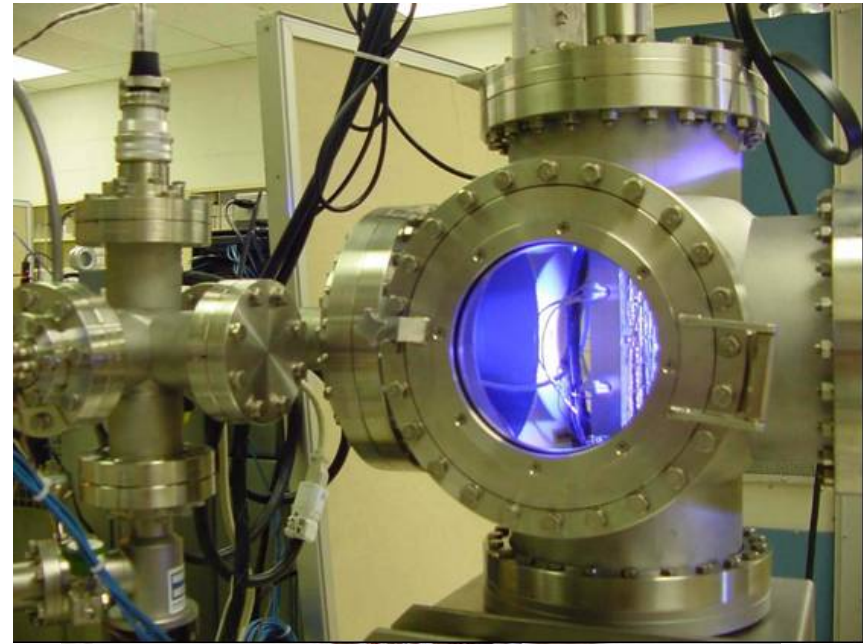
Near UV (NUV) and/or Vacuum UV (VUV)

System with NUV only

Variable Intensity Range

(1-5 Suns)

Thermally Controlled Sample Holder



Atomic Oxygen (AO)

Atomic Oxygen Beam Facility (AOBF)

- 5 eV Neutral Beam
- 10^{16} AO atoms/cm²sec
- Concurrent VUV Radiation (130 nm)

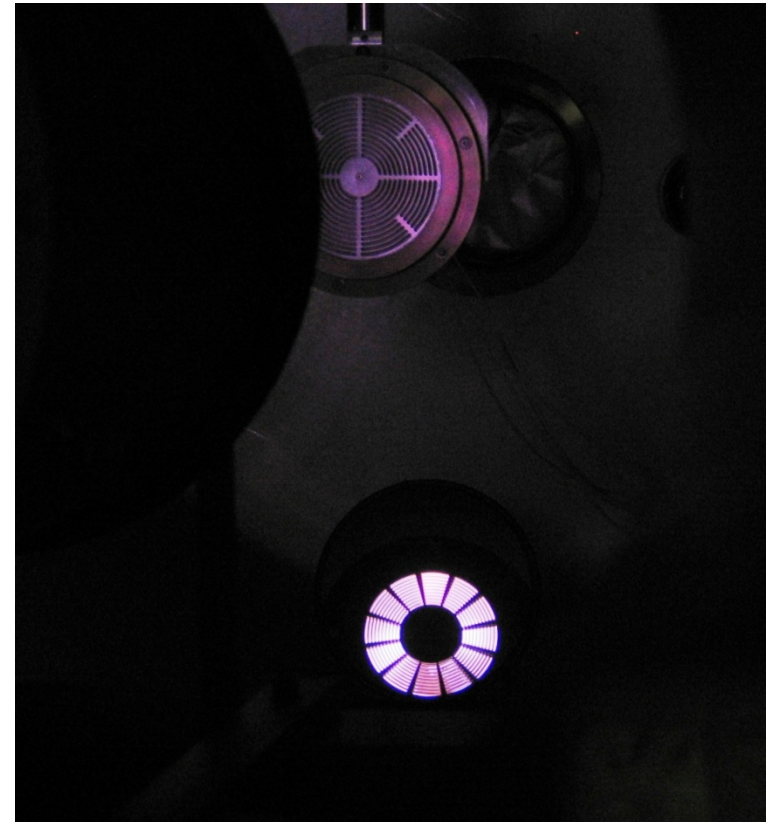
AO Drift Tube System (AOTDS)

- Thermal Energy
- Neutral AO Atoms
- NUV can be added



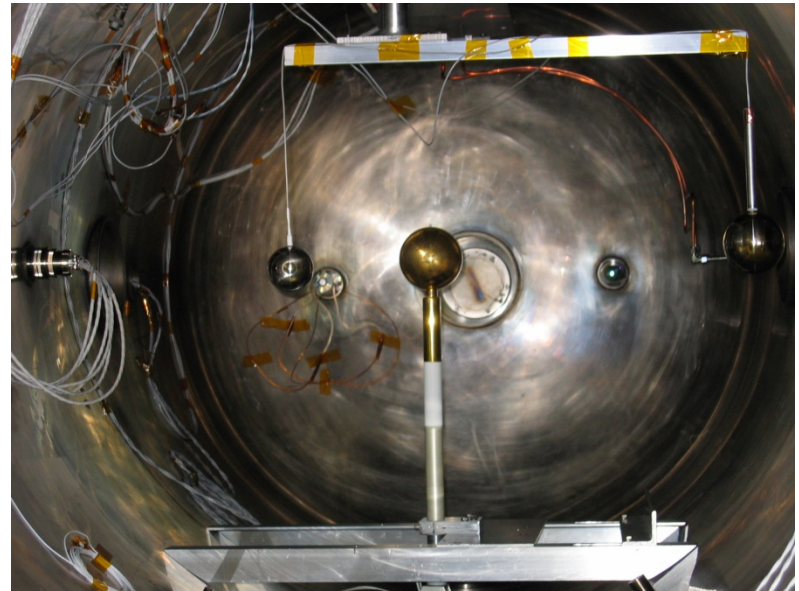
Space Plasma Interactions

- **LEO plasma** simulated using a magnetic filtered source
 - Electron Temperature Range (0.1 eV to 0.5 eV)
 - Plasma Density Range (10^4 - $10^6/\text{cm}^3$)
 - Monitored by Langmuir and emissive probes
- **GEO plasma** simulated using electron flood guns
 - Two flood guns exist to simulate high energy but low density environment.
 - Electron energies range from 1 to 100 keV.
- **Polar orbit conditions** are simulated using a combination of both the LEO and GEO sources discussed above
- Plasma Simulators are used to study:
 - Material conductivity
 - Arc characterization in both GEO and LEO
 - High voltage system interactions with plasma
- Test for Flight programs such as:
 - International Space Station Plasma Contactor Unit
 - ProSEDS tether and plasma contactor
 - Floating Potential Measurement Unit (FPMU)
 - National Polar Orbiting Environmental Satellite System (NPOESS)



Flight Instrumentation Qualification / Calibration

Floating Potential Measurement (FPMU) Wide Langmuir Probe (WLP)

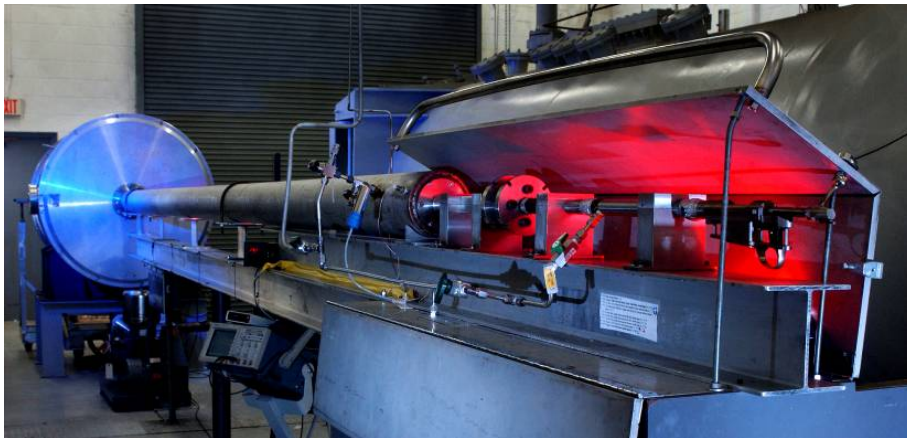


- Conducted a series of tests on the Wide Langmuir Probe (WLP), which is one of three plasma probes on the FPMU, to determine effects of contamination on measured plasma properties.
- Placed WLP probe from FPMU qualification test article in MSFC plasma chamber, operated probe similar to on-orbit operation and measured plasma properties in the chamber.
- Found WLP was susceptible to contamination, helping produce contamination control requirements for FPMU

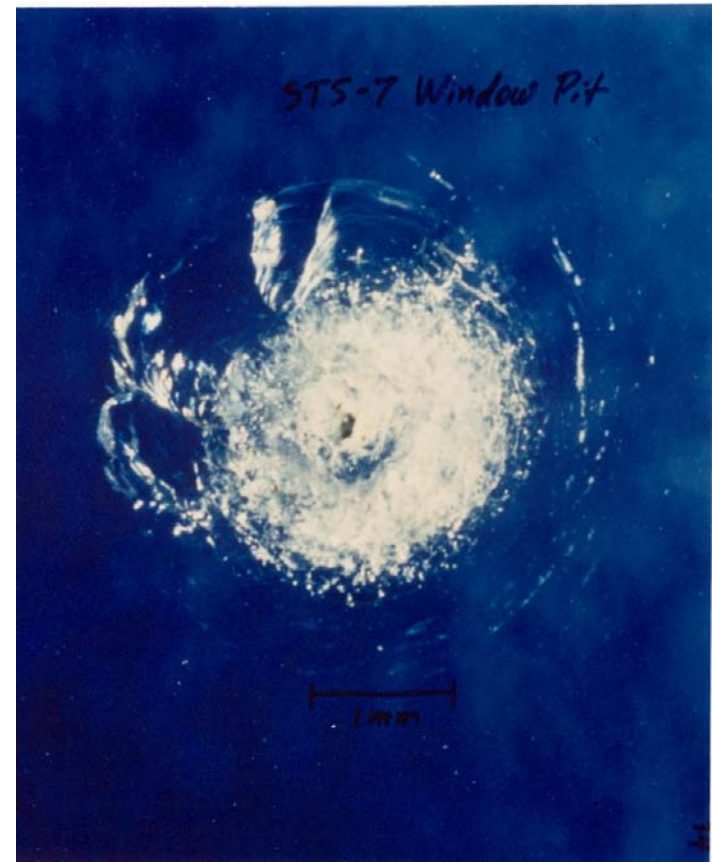
Hypervelocity Impact Range

- Capability for testing to support materials, component, and subsystem development and performance characterization
- Model validation testing

Micro-light Gas Gun (MLGG)



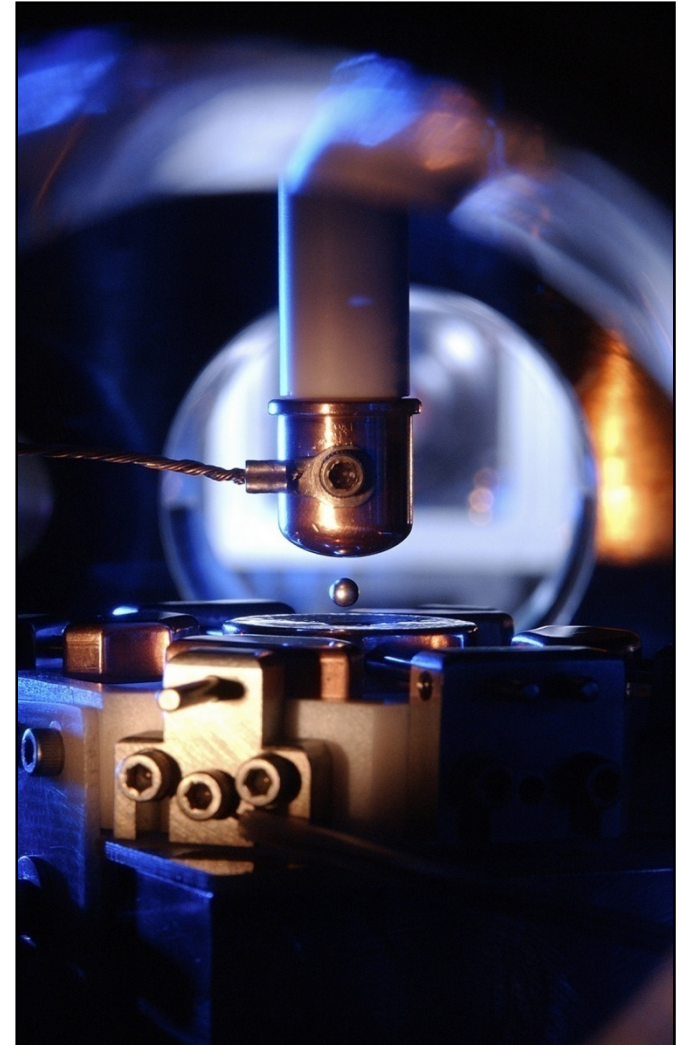
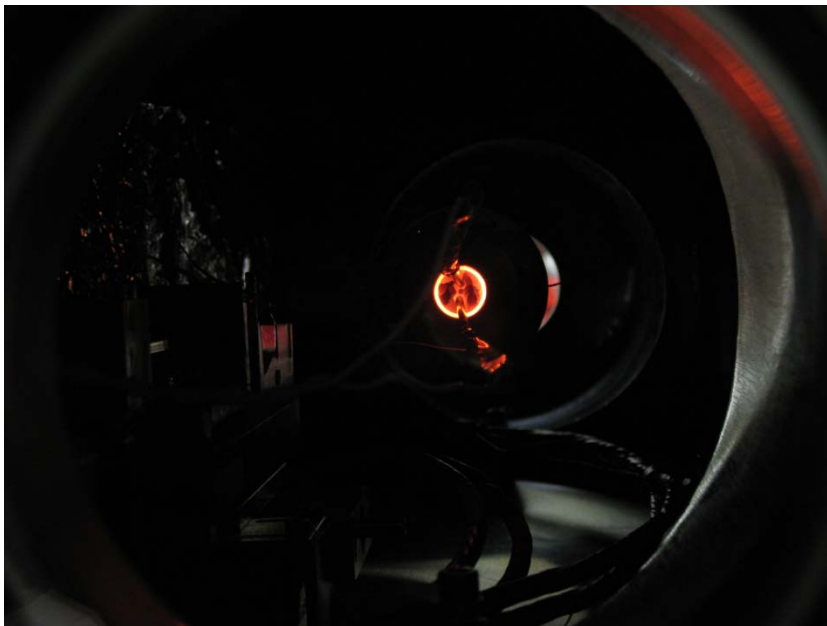
- Bore size up to 3 mm (0.1 in.) diameter
- Velocity Range: 0.3 – 7.5 km/s
- Target chamber approx 1 m (3 ft.) dia. X 2 m (6 ft.) long
- Shot Frequency: 5-7 per day



Shuttle Flight 7 – window impact

High Temperature Emissivity Measurement System (HiTEMS)

- Emissivity is a measure of a material's ability to transfer heat to the space vacuum
- HiTEMS offers a unique capability for measuring material emissivity from 300 K (27°C) to 3000 K (2700°C)
- Capability consists of 2 test systems:
 - HiTEMS provides emissivity from 330K to 1600 K
 - Ultra-HiTEMS provides emissivity from 1600K to 3000K



Materials and Processes Supporting Capabilities

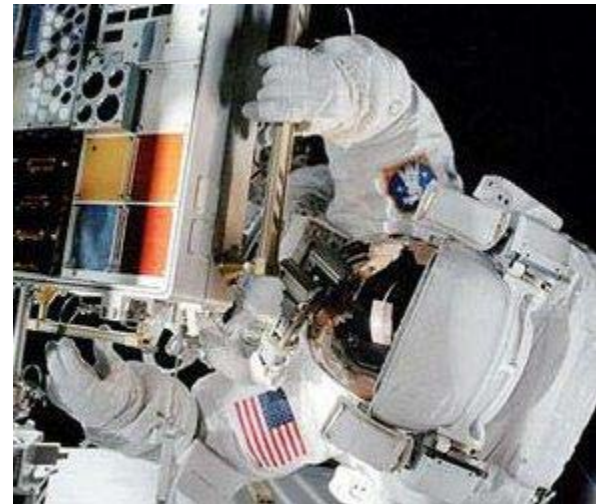
Analytical Capabilities

- Reflectance Measurements (AZ Tek LPSR)
- Transmission Measurements (PE UV/VIS/NIR Spectrometer)
- Infrared Reflectance Measurements (AZ Tek LPIR)
- Emittance Measurements (AZ Tek TEMP 2000)
- VUV Reflectance
- Fourier Transfer Infrared Spectroscopy (FTIR)
- Thin Films Tensile Testing



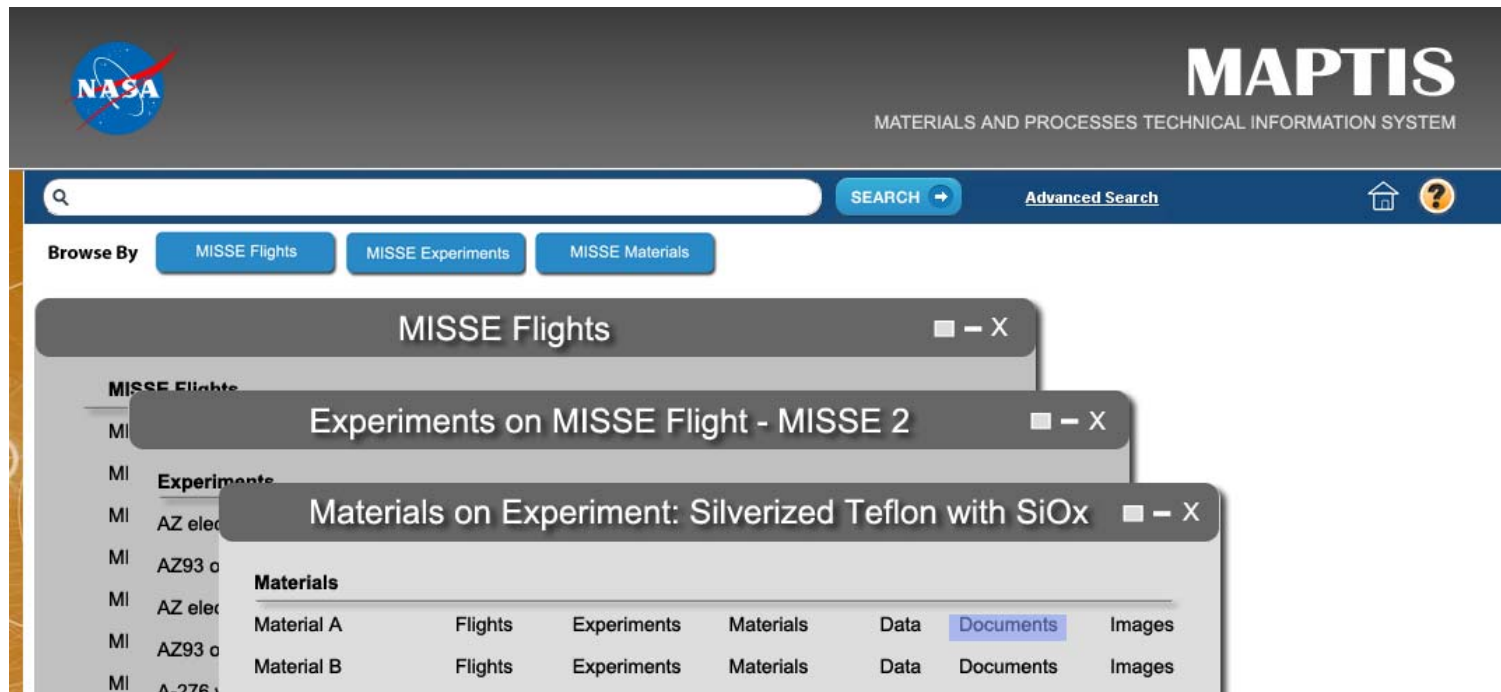
Other Materials and Processes Lab capabilities available:

- Materials and Processes Technical Information System (MAPTIS)
- Failure Analysis Laboratory
 - SEM, TEM, ESCA, Auger
- Mechanical Properties Testing
 - Metals and Non-Metals
- Chemistry
- Non-Destructive Evaluation (NDE)
- White Light Scanning
- Digital Manufacturing
- Composites development and manufacturing



Flight Materials Data

- MISSE data on MAPTIS
- Sample lists, presentations, papers, raw data, photos
- Searchable by material name, experiment, flight
- MISSE investigators are welcome to add their own data



Flight Materials Data

- For access to MAPTIS
- <http://maptis.nasa.gov/Request.aspx>
 - and fill out the form.
- To add MISSE data to MAPTIS
 - Contact ben.henrie@nasa.gov or miria.finckenor@nasa.gov
 - Miria – 256-544-9244
 - Be sure to specify whether your information is unlimited access or ITAR-restricted